and Mucuna. I saw very little that was new to me, but there was no time for any search. At forty miles we came to the River Lint, which at one time had a great reputation for its gold mines. Two Europeans have started to prospect the locality. We met with them on our return. They had found traces of very extensive workings in former times, but the whole are quite abandoned. The country around is hilly, and the banks of the river are beautifully picturesque. Scarcely any natives live in the vicinity.

We passed many small tributaries to the right and left, and at ninety-one miles, or eight days, from Pekan passed the Semanten, a large affluent coming from the west. Our course had been west hitherto, but now turned to the north-west. Our progress was but slow. We had hired a second boat, and both had to be urged against a strong current by means of long poles—the usual mode of up-stream progress in the Malaysia. One seldom averages more than a mile an hour in this way.

At about 130 miles we passed the Tomoleng, a large stream to the right. It was up this, I believe, that Baron Maclay passed in 1875. The river to the left is called the Jelis or Jelai. Between the two there is a very small stream which is called the Pahang. In Cameron's map the Jelai is marked as the Pahang, but the natives do not call it so. The Jelis is still a fine river, with fewer sandbanks, and I think a deeper bed. Fifty miles further we reached the Lipis. Where we left the Jelis it was still an important stream at least 200 yards wide. The Lipis is also a good stream, half the width of the former. We only went about ten miles up it, and at that distance or less came to Punjom, a large village, the second in importance to Pekan. We found that the cholera had just visited the place, and carried off half the inhabitants, and we found subsequently that several other villages had been visited, or were actually suffering from this terrible epidemic.

About three miles from Punjom is a celebrated gold mine at a village called Jelai, which has been worked for centuries. The formation is just like what is seen in the auriferous districts of Australia—that is to say, highly inclined slate schists and sandstones with quartz lodes containing the gold. The mines, I am told, have been worked in succession by Siamese, Malays, and Chinese. At present about thirty Chinese are employed, with a few Malays, who wash the sands for gold dust. The locality is very curious, from the evident antiquity of the workings. An enormous quantity of material has been quarried away, and shafts have been sunk in the solid rock. Subsequently the rock has been removed, leaving traces of the shafts on the faces of the quarries. It seems as if the miners had found gold in the alluvium, and then had removed the rock in searching for more. The lodes were scarcely touched, probably being too hard. But just beside the lodes the casing with some pockets of pyrites have been taken out in small quantities and are still worked. Doubtless these ores are rich, but a small quantity of free gold dust is all that these miners get.

The ground for acres around is covered with refuse heaps, and after each rainfall the native women and children may be seen searching for specks of gold in the sand. There is a good deal of iron pyrites in the heaps, and as this gradually decomposes, the gold is liberated in the form of fine dust. The mine is about to be worked by a European company.

I returned from Punjom down the Pahang as far as the Semanten, and ascended that river almost due west for about 50 miles. It then forks into the Karau (W.N.W.) and the Brentong (S.W.). As the latter was a series of rapids we changed our boats for small canoes. The water is very deep in places, but shallow at the rapids, where it falls over barriers of beautiful black marble with white veins, or over slate rocks, highly inclined and much jointed. It took us a whole day to ascend about 15 miles, as there was a fresh in the stream. This made the work of poling up the rapids difficult and exciting. After the first few miles we saw no habitations, but we met small bamboo rafts carrying down ingots of tin from the village of Brentong. The river flows in a channel about 50 yards wide, through a dense forest echoing with the cry of the large black siamang or gibbon monkey (*Hylobates syndactylus ?*). Occasionally we heard the peculiar warning shriek, as I may call it, of the wild aboriginal Sakei.

We left our canoes at the junction of a mountain torrent called the Dua. Here we camped one night, and then crossed to the sources of the stream, passing over several high mountain spurs from the main divide. In the mountains we found a few Malays washing stream tin from a shallow, coarse gravel. This consisted of broken Palæozoic slates and sandstones. We visited two or three mines of this kind in various places in the ranges. Travelling was very difficult, because of the undergrowth amid a fine forest of Dipterocarpus, oak, chestnut figs, Dammar, Fagræa, &c., with much Bertam palm (Huguessonia). Traces of tigers and elephants numerous. Game plentiful. In the river a very large barbel and a smaller one abundant (*Barbus burmanicus* and *Kolus ?*), both tasteless fishes and full of bones. We found also an eel-like voracious fish, which I took to be *Ophiocephalus micropeltes*, excellent eating, but uncommon. I have found the same fishes in all the mountain rivers of the Malay peninsula.

We returned direct to Pekau from the Sungei Dua, having spent about five weeks in the boats. Throughout we found the people affable and courteous, not timid of strangers, though some of them had never previously seen white men. Their only medium of exchange is a tin coinage, shaped for the most part like an old-fashioned square inkstand. They objected to receive the smaller silver coin of the Straits Settlements, but would take an empty bottle or a meat or biscuit tin in exchange for a fowl, and fruit such as bananas, cocoa-nuts, mangostems, and papaws, besides tapioca, maize, and brinjals.

We saw a few slaves, who seemed to be Sakeis or Africans. The whole population of the State can scarcely be 50,000, of which probably not 500 are Chinese.

About half way between the dividing range and the sea there is a belt of detached conical steep mountains 1500 to 2000 feet high. From the specimens of rock abutting on the River Pahang I judge these hills to be volcanic, and to consist of trachytic and felspathic rocks. I also found in the bed of the stream isolated patches of andesite, felsite, molaphyre, and limestone. In respect to the volcanic rocks the eastern side of the Malay peninsula differs much from the western. J. E. TENISON-WOOD

Singapore, August 28

P.S.—I have just seen in a number of NATURE, published in the early part of this year, a letter from Mr. L. Wray, jun., correcting what he considers certain mistakes of mine. It is due to your readers to state that I do not accept any of these corrections. During the long period that I have spent in exploring in these regions, Mr. Wray travelled with me for about a fortnight. I should like to repeat that I have never seen on the Malay peninsula any sign of upheaval or subsidence. The instance Mr. Wray refers to at Matang obviously admits of a very different interpretation.

THE CRETACEOUS FLORAS OF CANADA[1]

Geological Relations of the Floras

IN a memoir published in the first volume of the *Transactions* of this Society I have given a table of the Cretaceous formations of the western North-

[1] By Sir William Dawson, F.R.S., &c. From advance sheets of a memoir to appear in the *Transactions* of the Royal Society of Canada.

West Territories of Canada, prepared by Dr. G. M. Dawson, and have fully stated the geological position of the plants at that time described. The new facts detailed now require us to intercalate in our table three distinct plant-horizons not previously recognised in the western territories of Canada. One of these, the Kootanie series, should probably be placed at the base of the table as a representative of the Urgonian or Neocomian, or, at the very least, should be held as not newer than the Shasta group of the United States Geologists, and the Lower Sandstones and Shales of the Queen Charlotte Islands. It would seem to correspond in the character of its fossil plants with the oldest Cretaceous floras recognised in Europe and Asia, and with that of the Komé formation in Greenland, as described by Heer. No similar flora seems yet to have been distinctly recognised in the United States, except, perhaps, that of the beds in Maryland, holding cycads, and which were referred many years ago by Tyson to the Wealden.

The second of these plant-horizons separated, according to Dr. G. M. Dawson, by a considerable thickness of strata, is that which he has called the Mill Creek series, and which corresponds very closely with that of the Dakota group, as described by Lesquereux, and that of the Atané and Patoot formations in Greenland, as described by Heer. This fills a gap, indicated only conjecturally in the table of 1883. Along with the plants from the Dunvegan group of Peace River, described in 1883, it would seem to represent the flora of the Cenomanian and Turonian divisions of the Cretaceous in Europe.

Above this we have also to intercalate a third sub-flora, that of the Belly River series at the base of the Fort Pierre group. This, though separated from the Laramie proper by the marine beds of the Pierre and Fox Hill groups, more than 1700 feet in thickness, introduces the Laramie or Danian flora, which continues to the top of the Cretaceous, and probably into the Eocene, and includes several species still surviving on the American continent, or represented by forms so close that they may be varietal merely.

Lastly, the subdivision of the Laramie group, in the last Report of Dr. G. M. Dawson, into the three members known respectively as the Lower or St. Mary River series, the Middle or Willow Creek series, and the Upper or Porcupine Hill series, in connection with the fact that the fossil plants occur chiefly in the lower and upper members, enables us now to divide the Laramie flora proper into two sub-floras—an older, closely allied to that of the Belly River series below; and a newer, identical with that of Souris River, described as Laramie in Dr. G. M. Dawson's Report on the 49th Parallel, 1876, and in the Report of the Geological Survey of Canada for 1879, and which appears to agree with that known in the United States as the Fort Union group, and in part at least with the so-called Miocene of Heer from Greenland.

From the animal fossils and the character of the flora it would seem probable that the rich flora of the Cretaceous coal-fields of Vancouver Island is nearly synchronous with that of the coal-bearing Belly River series of the western plains.

It will thus be seen that the explorations already made in Canadian territory have revealed a very complete series of Cretaceous plants, admitting, no doubt, of large additions to the number of species by future discoveries, and also of the establishment of connecting links between the different members, but giving a satisfactory basis for the knowledge of the succession of plants and for the determination of the ages of formations by their vegetable fossils.

The successive series may be tabulated as follows, with references for details to the fuller table in my memoir of 1883:—

Successive Floras and Sub-Floras of the Cretaceous in Canada (in Descending Order)

Periods	Floras and Sub-Floras	References
Transition Eocene to Cretaceous	Upper Laramie or Porcupine Hill Series ...	Platanus beds of Souris River and Calgary. Report Geol. Survey of Canada for 1879, and memoir of 1885.
Upper Cretaceous (Danian and Senonian)	Middle Laramie or Willow Creek Series.	
	Lower Laramie or St. Mary River Series ...	Lemna and Pistia beds of bad lands of 49th Parallel, Red Deer River, &c., with Lignites. Report 49th Parallel and memoir of 1885.
	Fox Hill Series	Marine.
	Fort Pierre Series	Marine.
	Belly River Series. (See note.)	Sequoia and Brasenia beds of S. Saskatchewan, Belly River, &c., with Lignites. Memoir of 1885.
	Coal Measures of Nanaimo, B.C., probably here ...	Memoir of 1883. Many Dicotyledons, Palms, &c.
Middle Cretaceous (Turonian and Cenomanian)	Dunvegan Series of Peace River. (See note.) ...	Memoir of 1883. Many Dicotyledons, Cycads, &c.
	Mill Creek Series of Rocky Mountains	Dicotyledonous leaves, similar to Dakota Group of the U.S. Memoir of 1885.
Lower Cretaceous (Neocomian, &c.)	Suskwa River and Queen Charlotte Island Series. Intermediate Series of Rocky Mountains ...	Cycads, Pines, a few Dicotyledons. Report Geol. Survey. Memoir of 1885.
	Kootanie Series of Rocky Mountains	Cycads, Pines, and Ferns. Memoir of 1885.

NOTE.—Though the flora of the Belly River Series very closely resembles that of the Lower Laramie, showing tha similar plants existed throughout the Senonian and Danian periods in North America, yet it is to be anticipated that specific differences will develop themselves in the progress of discovery. In the meantime it scarcely seems possible to distinguish by fossil plants alone the Lower Laramie beds from those of Belly River, and if these are really separated by 1700 feet of marine strata, as is now believed on stratigraphical grounds, the flora must have been remarkably persistent. The Dunvegan series of Peace River probably corresponds in time with the marine Niobrara and Benton groups farther south, and the Mill Creek with the Dakota group

Physical Conditions and Climate indicated by the Cretaceous Floras.—In the Jurassic and earliest Cretaceous periods the prevalence, over the whole of the Northern Hemisphere, and for a long time, of a monotonous assemblage of Gymnospermous and Acrogenous plants, implies an uniform and mild climate and facility for intercommunication in the north. Towards the end of the Jurassic and beginning of the Cretaceous, the land of the Northern Hemisphere was assuming greater dimensions, and the climate probably becoming a little less uniform. Before the close of the Lower Cretaceous period, the dicotyledonous flora seems to have been introduced, under geographical conditions which permitted a warm-temperate climate to extend as far north as Greenland.

In the Cenomanian we find the Northern Hemisphere tenanted with dicotyledonous trees closely allied to those of modern times, though still indicating a climate much warmer than that which at present prevails. In this age extensive but gradual submergence of land is indicated by the prevalence of chalk and marine limestones over the surface of both continents; but a circumpolar belt of land seems to have been maintained, protecting the Atlantic and Pacific basins from floating ice, and permitting a temperate flora of great richness to prevail far to the north, and especially along the southern margins and extensions of the circumpolar land. These seem to have been the physical conditions which terminated the existence of the old Mesozoic flora and introduced that of the Middle Cretaceous.

As time advanced, the quantity of land gradually increased, and the extension of new plains along the older ridges of land was coincident with the deposition of the great Laramie series and with the origination of its peculiar flora, which indicates a mild climate and considerable variety of station in mountain, plain, and swamp, as well as in great sheets of shallow and weedy fresh water.

In the Eocene and Miocene periods the continent gradually assumed its present form, and the vegetation became still more modern in aspect. In that period of the Eocene, however, in which the great nummulitic limestones were deposited, a submergence of land occurred on the eastern continent which must have assimilated its physical conditions to those of the Middle Cretaceous. This great change, affecting materially the flora of Europe, was not equally great in America, which also by the north and south extension of its mountain chains permitted movements of migration not possible in the Old World. From the Eocene downwards, the remains of land animals and plants are found only in lake basins occupying the existing depressions of the land, though more extensive than those now remaining. It must also be borne in mind that the great foldings and fractures of the crust of the earth which occurred at the close of the Eocene, and to which the final elevation of such ranges as the Alps and the Rocky Mountains belongs, permanently modified and moulded the forms of the continents.

These statements raise, however, questions as to the precise equivalence in time of similar floras found in different latitudes. However equable the climate, there must have been some appreciable difference in proceeding from north to south. If, therefore, as seems in every way probable, the new species of plants originated on the Arctic land and spread themselves southward, this latter process would occur most naturally in times of gradual refrigeration or of the access of a more extreme climate, that is, in times of the elevation of land in the temperate latitudes, or conversely, of local depression of land in the Arctic, leading to invasions of northern ice. Hence the times of the prevalence of particular types of plants in the far north would precede those of their extension to the south, and a flora found fossil in Greenland might be supposed to be somewhat older than a similar flora when found farther south. It would seem, however, that the time required for the extension of a new flora to its extreme geographical limit, is so small in comparison with the duration of an entire geological period, that practically, this difference is of little moment, or at least does not amount to antedating the Arctic flora of a particular type by a whole period, but only by a fraction of such period.

It does not appear that during the whole of the Cretaceous and Eocene periods there is any evidence of such refrigeration as seriously to interfere with the flora, but perhaps the times of most considerable warmth are those of the Dunvegan group in the Middle Cretaceous and those of the later Laramie and oldest Eocene.

It would appear that no cause for the mild temperature of the Cretaceous needs to be invoked other than those mutations of land and water which the geological deposits themselves indicate. A condition, for example, of the Atlantic basin in which the high land of Greenland should be reduced in elevation and at the same time the northern inlets of the Atlantic closed against the invasion of Arctic ice, would at once restore climatic conditions allowing of the growth of a temperate flora in Greenland. As Dr. Brown has shown ("Florula Discoana"), and as I have elsewhere argued, the absence of light in the Arctic winter is no disadvantage, since, during the winter, the growth of deciduous trees is in any case suspended, while the constant continuance of light in the summer is, on the contrary, a very great stimulus and advantage.

It is a remarkable phenomenon in the history of genera of plants in the later Mesozoic and Tertiary, that the older genera appear at once in a great number of specific types, which become reduced as well as limited in range down to the modern. This is no doubt connected with the greater differentiation of local conditions in the modern; but it indicates also a law of rapid multiplication of species in the early life of genera. The distribution of the species of *Salisburia*, *Sequoia*, *Platanus*, *Sassafras*, *Liriodendron*, *Magnolia*, and many other genera, affords remarkable proofs of this.

Gray, Saporta, Heer, Newberry, Lesquereux, and Starkie Gardner, have all ably discussed these points; but the continual increase of our knowledge of the several floras, and the removal of error as to the dates of their appearance must greatly conduce to clearer and more definite ideas. In particular, the prevailing opinion that the Miocene was a period of the greatest extension of warmth and of a temperate flora into the Arctic, must be abandoned in favour of the later Cretaceous and Eocene; and if I mistake not, this will be found to accord better with the evidence of general geology and of animal fossils.

NOTE.—While this memoir was passing through the press, the Report of Mr. Whiteaves, F.G.S., Palæontologist to the Canadian Survey, on the invertebrate fossils of the Laramie and Cretaceous of the Bow and Belly River districts appeared ("Contributions to Canadian Palæontology," vol. i. part 1, 89 pp. and 11 plates). This valuable Report constitutes an independent testimony, based on animal fossils, to the age of the beds in question, and accords in the main very closely with the conclusions above derived from fossil plants. Unfortunately, however, no animal remains have yet been found in the Kootanie series, and the only fossil recorded from the Mill Creek beds is a species of *Inoceramus* characteristic in the United States of the Niobrara and Benton groups, a position a little higher than that deduced from the plants.